SOYBEAN RESPONSE TO STARTER FERTILIZER IN CONSERVATION TILLAGE SYSTEMS

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ABSTRACT

A three-year study (1991-931 of tillage and N, P and K liquid starter fertilizer in selected combinations indicated that tillage and N, P and K fertilizer combinations had no effect on soybean [Glycine max (L.) Merr] yield, seed test weight, and percent leaf N, P and K. Orthogonal statistical analysis (averaged over years), however, indicated that no-tillage produced higher yield than reduced and conventional tillage. No-tillage plants were taller than reduced tillage and conventional tillage treatments. Seed mass showed differences only in 1992 but did not relate to yield. Plant populations were statistically different in 1992 and 1993. However, plant populations were above 82,000 plantslac, adequate for maximum yield. Soil temperature data at the one-inch depth during emergence showed no difference in temperature between no-tillage and conventional tillage in 1991 and 1992. In 1993, however, the no-tillage temperatures often were sightly higher than conventional tillage during the emergence period.

In conclusion, late maturity group IV soybean produced acceptable yield planted in April with either no-tillage, reduced tillage, or conventional tillage. The results are in agreement with other research (Mengel et al., 1987) which indicate no response to P and K fertilizer when soil test levels of both P and K were in the medium to medium-high range.

INTRODUCTION

Mississippi soybean producers are interested in moving a part of their acreage to highly productive Group IV maturity varieties which will allow them to reduce the number of irrigations and have greater opportunity for fall tillage and more flexibility in a rotation with wheat or other fall planted crops while maintaining acceptable yields. However, early planting is subject to heavy rainfalls during planting and high humidity during harvest increasing the chances for phomposis seed decay. Caviness and Mayhew (1994) showed that these environmental effects may be reduced by breeding varieties resistant to phomposis seed decay. Accelerating the early growth of Group IV maturity through varieties resistant to phomposis seed decay and proper tillage methods may expand the window of opportunity for early planted Maturity Group IV soybeans.

Limited research information (Kamprath, 1989, and Touchton and Rickerl, 1986) is available on early planted soybean response to starter fertilizer in conservation tillage systems. On sandy Coastal Plain soils, Kamprath (1989) reported that soybeans do not response to fertilization when P soil test values were greater than 80 lb/ac on poorly drained soils (typical soil characteristic of northeast Mississippi). Nor, did they respond to fertilization when K soil test values were greater than 140 lb/ac (Kamprath, 1989). However, starter fertilizers can increase plant growth when the root growth is restricted or when temperatures remain cool. Touchton and Rickerl, (1986) reported that N-P-K starter fertilizers did increase yield, plant root growth and top weights in soils with high test P, K values, but had a greater effect when residual P, K, or both are low. However, Nitrogen fertilization during planting and flowering has shown to increase soybean yield (Reese and Buss, 1992).

April planted Group IV soybean (Riverside 499). response to starter fertilizer was evaluated in 3 tillage environments. The effect of tillage and N, P, and K applied as a starter fertilizer alone and in selected combinations on soybean grain yield, seed mass, seed test weight, leaf N, P and K, and plant height at maturity was evaluated.

MATERIALS AND METHODS

The study was conducted in 1991-93 at the Mississippi State University, Northeast Branch of the Mississippi Agriculture and Forestry Experiment Station, Verona, MS. The study was located on the same site for the duration of the study and soil test results indicated medium to high in both P and K. The experimental design was a randomized complete block with 5 replications and plots were 15 ft wide x 30 ft long.

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Table 1. Liquid fertilizer solution mixtures and sources.

N-P_2O_5-K_2O lb/ac	Sources Description
15-30-0	Mixture of N-Sol-32 (liquid N solution) and 10-34-0
0-30-0	Mixing reagent grade phosphoric acid with water
0-0-30	Commercial liquid fertilizer K solution
15-30-30	3-18-18 commercial liquid fertilizer was mixed with Urea to bring the N-P-K ratio to 1:2:2
15-0-0	N-Sol-32

Table 2. Soybean yield response to tillage and N, P. and K fertilizer rate applied as a surface band application on a Leeper silty clay soil in 1991-1993 at the MAFES Northeast Mississippi Branch Station. Verona, MS.

Tillage Fertilizer/ N-P_2O_5-K_2O lb/ac*	1991	1992	1993	mean
		bu/ac		
No-Tillage				
1. 15-30-30	37.5	52.9	41.3	43.9
2. 15-30-0	33.2	48.4	39.5	40.4
3. 0-30-0	32.4	48.6	38.3	39.8
4. 15-0-0	37.8	50.7	38.5	42.3
5. 0-0-30	29.8	51.3	36.2	39.1
6. 0-0-0	34.5	48.1	37.2	40.0
B. Reduced Tillage				
7. 15-30-30	32.2	41.9	39.1	37.7
8. 15-30-0	29.1	48.7	37.6	38.5
9. 0-30-0	29.5	49.4	39.6	39.5
10. 15-0-0	30.6	48.4	36.4	39.1
11. 0-0-30	33.8	48.2	36.7	39.6
12. 0-0-0	31.2	49.4	37.5	39.4
C. Conventional Tillage				
13. 15-30-30	33.0	19.1	35.7	39.3
14. 0-0-0	29.7	46.5	34.3	36.8
LSD 0.05	NS	NS	NS	3.7
CV %	15.9	12.5	9.2	12.9

*All N-P-K fertilizer applied as a 4-in wide surface band over the planted row,

Due to excessive rainfall and wet soil conditions experienced during April and May of 1991, which delayed planting until early June, a decision was made to put all the tillage treatments (in the fall of 1991) on beds or ridges in the following manner: no-till (bedding); reduced tillage lone-pass with field cultivator 3 inches deep plus bedding followed by a doalled before planting); and conventional tillage [field cultivated (5 to 6 inches deep), disked twice plus bedding and doalled before planting]. No-till plots were not tilled in the fall of 1992. The reduced tillage and conventional tillage treatments were repeated in the fall of 1992.

No-tillage plots, only in 1993, received an application of 2.4-D at 0.75 lb a/lac on 2/10/93. Each year Gramoxone (paraquat) + surfactant at 0.62 lb ailac + 0.4 pt/ac was applied as a burndown application to the no-till and reduced tillage treatments five to ten days before planting. All reduced tillage and conventional tillage plots were smoothed with a row conditioner before planting. Gramoxone + Prowl (pendimethalin) + Scepter (imazaquin) + surfactant were applied preemergence at 0.25 + 0.8 + 0.06 lb ailac + 0.4 pt/ac over no-tillage and reduced tillage plots. Prowl + Scepter at 0.8 + 0.06 lb ailac was applied preemergence to conventional tillage plots in both study. No postemergence herbicides were required during the growing seasons. One application of dimethoate was applied 5/02/92 for bean leaf beetle control.

Maturity Group IV soybean variety, Riverside 499, was planted on 6/05/91. 4/09/92. and 4/28/93, with a CASE-IH 900 Early Riser planter at 9 seed/ft in 30-inch rows. All starter fertilizer solutions were applied as a surface band (4-inch wide) during the planting operation (Table 1). The N, P and K liquid fertilizer solution mixtures were made by mixing different N, P and K sources to obtain the appropriate solutions. All fertilizer IN-P-K) solutions (Table 2) were applied as a surface band using a fan nozzle (8002-VS) mounted behind the planter press wheel.

Data collected were plant population, early bloom leaf N, P and K content, seed yield, plant height at maturity, seed test weight, and 1000 seed weight (gm/1000 seed). Soil temperatures at 1-inch depth in the no-tillage and conventional tillage plots were measured for the first 3 wk after planting in 1991, 1992, and 1993. A data logger with soil thermocouples placed at the 1-inch depth was used to record soil temperatures every minute. Ten mature trifoliate leaves from the upper most part of the plant in the center two rows of each plot were collected at early bloom for N, P and K analyses. The leaf samples were dried at 75° C for 48 hr and analyzed for N, P and K by appropriate chemical analysis.

The center two rows of each plot were harvested each year in late September or early October with a plot combine. Plot seed yield were weighed and adjusted to bushels per acre utilizing *'yield cal'* a basic computer program. Plot seed test weight and moisture were determined by a GAC II Dickey John Seed Analyzer. Random seed samples of 1000 seed from each harvested plot were weighed. Plant population data was collected from four 3-ft samples of row selected at random in the center 2 rows of each 6-row plot. Plant height at maturity was obtained by measuring the height lfrom the soil surface to the upper most growing point) of 5 consecutive plants from a randomly selected point in both of the center 2 rows of each plot. All data was subjected to statistical analysis (SAS, Cary, N.C.) and means were separated by Least Significant Differences (LSD) at the 0.05 probability level.

RESULTS AND DISCUSSION

Soil temperatures for 3 wk after planting in 1991 and 1992 (data not shown) showed no difference between no-tillage and conventional tillage. In 1992 the conventional tillage soil temperature ranged from a low of 46° F on April 29 to a high of 9 0 F on April 17. Seven of 14 days, April 17 to 30, the minimum soil temperature was below 6 0 F. Four of these 7 days, however, occurred April 27 to April 30. On the contrary, soil temperature in 1993 showed differences between no-tillage (Figure 1) and conventional tillage and generally the no-tillage had slightly higher temperature than conventional tillage. This difference may be due to conventional tillage having greater water infiltration than no-tillage (more water in the soil profile) thereby requiring more energy to warm the soil. The conventional tillage also may have had a rougher surface and, therefore, receive less direct sunlight. Nine of 21 days (May 1 to May 21) in 1993, the minimum soil temperature was below 60°F. Soil temperature from May 1 to May 21 ranged from a low of 53°F to a high of 9 2 F in no-tillage.

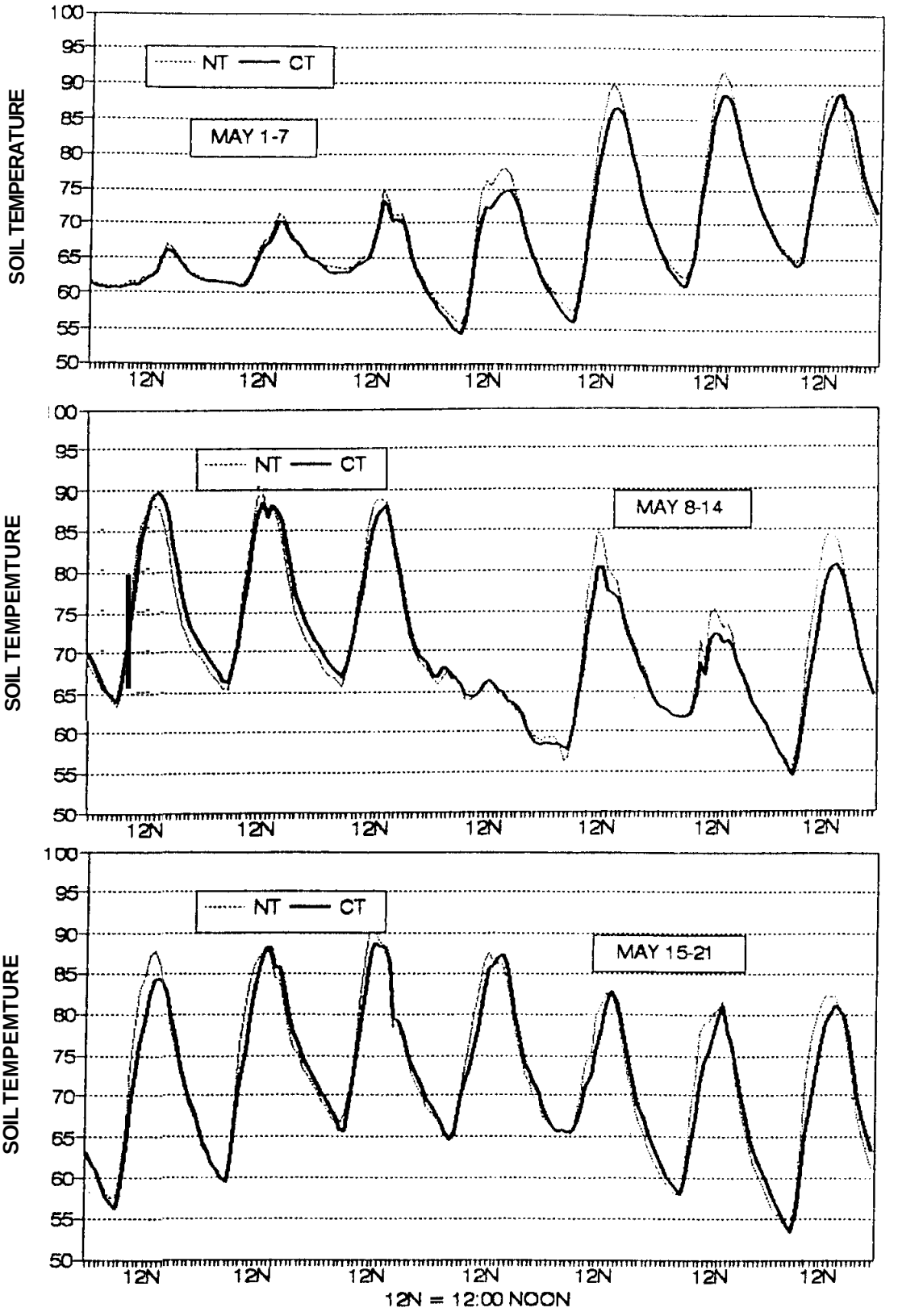

Figure 1. Soil temperatures at 1 inch depth for May 1-21, 1993, Northeast Mississippi Research and extension Center.

Table 3. Soybean plant height and yield. averaged over years 11991-93) and fertilizer rate, response to tillage systems at the MAFES Northeast Mississippi Branch Station, Verona, MS.

Tillage Svstem	Yield bu/ac	Plant Ht(in)
No-tillage	41.0a*	41.2a
Reduced-tillage	38.9b	39.5b
Conventional tillage	38.1b	40.2b

* Numbers in a column with the same lower case letters is not significantly different according to DNMRT at the 5% probability level.

Table 4. Soybean seed weight response to tillage and starter fertilizer applied as a surface band application on a Leeper silty clay soil (1991-93) at the MAFES Northeast Mississippi Branch Station, Verona, MS.

Tillage Fertilized N-P_2O_5-K_2O lb/ac*	1000 Seed weight 1991	1992	1993	mean
		gm		
A. No-Tillage				
1. 15-30-30	124.7	141.8	133.9	133.5
2. 15-30-0	125.1	135.7	134.2	131.7
3. 0-30-0	129.1	138.2	130.5	132.6
4. 15-0-0	122.4	140.0	132.3	131.6
5. 0-0-30	124.6	136.5	129.7	130.3
6. 0-0-0	124.3	137.3	132.8	131.5
B. Reduced Tillane				
7. 15-30-30	125.5	142.8	131.8	133.4
8. 15-30-0	124.8	135.6	133.9	131.4
9. 0-30-0	124.6	139.4	137.6	133.9
10. 15-0-0	120.6	133.6	133.3	129.2
11. 0-0-30	120.8	135.1	131.6	129.2
12. 0-0-0	123.9	133.1	131.8	129.6
C. Conventional Tillage				
13. 15-30-30	120.4	132.9	132.8	128.7
14. 0-0-0	123.0	135.8	131.9	130.2
LSD 0.05	NS	9.3	NS	3.7
CV %	3.3	5.8	4.8	1.7

* All N-P-K fertilizer solutions applied as a 4-in wide surface band over the planted row.

Tillage and fertilizer combinations had no effect on yield all three years of the study (Table 2). The 3 yr (1991-93) average, however, indicated that the 15-30-30, (N-P_2O_5-K_2O) lb/ac rate with no-tillage produced higher yield than all tillage checks (no fertilizer). 0-30-0, 0-0-30 no-tillage treatments and all conventional and reduce tillage treatments. Orthogonal statistical analysis indicated that averaged over years and fertilizer treatments, no-tillage produced higher yield than reduced tillage and conventional tillage (Table 3).

Seed mass data (Table 4) indicated that 2 of 3 years neither fertilizer nor tillage combinations had

any effect on seed mass. However, the 15-30-30 reduced tillage and no-tillage treatments had higher seed mass in 1992 than the 15-30-30 conventional tillage. The 3-yr average data indicated that 15-30-30 in no-tillage and reduced tillage had higher seed mass than conventional tillage, and the reduced tillage check, 0-0-30 and 15-0-0 treatments.

Seed test weight showed difference in 2 of 3 years (Table 5). The 15-30-0 no-tillage and reduced tillage treatments had the highest test weight but was only different from the 0-30-0 reduced tillage treatment in 1992. The 15-30-30 reduced tillage treatment in 1993 had the highest test weight but was different from 0-0-30 and 15-30-0 reduced tillage treatments, 0-0-0, 0-0-30 and 0-30-0 no-tillage and 0-0-0 conventional tillage treatments. The 3-year mean seed test weight, however, showed no response to fertilizer and tillage. Plant height at maturity (Table 6) indicated that in 1991 the no-tillage 15-30-30 was taller than all reduced tillage and conventional treatments, There was no difference in plant height in 1992 and 1993. Orthogonal analysis indicated that averaged over years and fertilizer, no-tillage was taller than conventional and reduced tillage (Table 3). There was no difference between reduced tillage and conventional tillage.

Plant populations showed differences between fertilizer and tillage treatment in 1992 and 1993 (Table 7). The 3-year mean, however. showed no difference in plant population in all treatments. Populations all three years, however, were above 80,000 plants/ac for all treatments, more than sufficient for maximum yield (Doss and Thurton, 1974 and Ramseur et al.. 1984). Soybean leaf tissue analyses, averaged over years, for N, P and K at early bloom, indicated no differences between tillage and fertilizer treatments (Table 8).

The results indicated that late maturity group IV soybeans produced acceptable yield planted in April with either no-tillage, reduced tillage, or conventional tillage. The results are in agreement with other reported research (Mengel et al., 1987) that starter fertilizer is not necessary when soil test levels of both P and K are in the medium to medium-high range.

Table 5. Soybean seed test weight response to tillage and starter fertilizer applied as a surface band application on a Leeper silty clay soil (1991-93) at the MAFES Northeast Mississippi Branch Station, Verona, MS.

Tillage Fertilizer/ N-P_2O_5-K_2O lb/ac*	Seed test weight 1991	1992	1993	mean
		lb/bu		
A. No-Tillaae				
1. 15-30-30	**55.2**	**54.1**	**54.5**	**54.6**
2. 15-30-0	**55.0**	**54.7**	**55.4**	**55.0**
3. 0-30-0	**54.7**	**54.2**	**55.2**	**54.7**
4. 15-0-0	55.3	54.5	54.8	54.9
5. 0-0-30	54.9	54.4	54.2	54.5
6. 0-0-0	55.0	54.3	55.0	54.8
B. Reduced Tillage				
7. 15-30-30	54.3	54.4	56.2	55.0
8. 15-30-0	55.3	54.6	55.2	55.0
9. 0-30-0	55.3	52.9	55.3	54.5
10. 15-0-0	55.1	54.4	55.4	55.0
11. 0-0-30	54.6	54.6	55.1	54.8
12. 0-0-0	55.4	54.1	55.5	55.0
C. Conventional Tillage				
13. 15-30-30	55.8	54.7	55.3	55.3
14. 0-0-0	**54.9**	**54.6**	**55.2**	54.9
LSD 0.05	**NS**	1.3	0.9	**NS**
CV %	***2.0***	2.0	1.2	**0.8**

*** All N-P-K fertilizer solutions applied as a 4-in wide surface band over the planted row.**

Table 6. Soybean plant height at maturity response lo tillage and starter fertilizer 11991-93) on a Leeper silty clay soil at the MAFES Northeast Mississippi Branch Station. Verona, MS.

Tillage/Fertilizer $N-P_2O_5-K_2O$ lb/ac	Plant Height 1991	1992	1993	mean
			inches	
A. No-Tillage				
1. 15-30-30	31.0	50.7	46.9	42.9
2. 15-30-0	29.8	48.9	45.9	41.5
3. 0-30-0	29.2	49.1	43.4	40.6
4. 15-0-0	30.2	50.2	44.4	41.6
5. 0-0-30	29.4	48.9	43.4	40.6
6. 0-0-0	30.0	47.6	43.5	40.4
8. Reduced Tillaae				
7. 15-30-30	27.6	48.8	42.1	**39.5**
8. 15-30-0	28.0	48.0	43.4	**39.8**
9. 0-30-0	28.0	46.6	42.3	**38.9**
10. 15-0-0	27.6	48.1	39.8	38.5
11. 0-0-30	27.6	47.6	44.9	40.0
12. 0-0-0	28.4	48.7	42.7	39.9
C. Conventional Tillaae				
13. 15-30-30	28.4	49.6	43.8	**40.6**
14. 0-0-0	27.4	41.3	44.5	39.7
LSD.05	1.8	NS	NS	1.8
CV %	5.0	4.1	7.6	6.2

Table 7. Soybean plant population for tillage and starter fertilizer (1991-93) on a Laeper silty clay soil at the MAFES Northeast Mississippi Branch Station. Verona. MS.

Tillage/fertilizer $N-P_2O_5-K_2O$ lb/ac	Plant Population/ac X 1000 1991	1992	1993	mean
A. No-Tillage				
1. 15-30-30	129.2	85.6	106.2	107.0
2. 15-30-0	122.4	90.6	114.0	109.0
3. 0-30-0	122.4	**90.8**	100.6	104.6
4. 15-0-0	115.2	94.6	118.6	109.5
5. 0-0-30	125.8	98.8	114.0	112.9
6. 0-0-0	101.2	99.8	116.6	105.9
B. Reduced Tillage				
7. 15-30-30	118.6	98.6	86.6	101.3
8. 15-30-0	115.2	97.6	97.8	103.5
9. 0-30-0	118.8	95.6	**105.8**	106.7
10. 15-0-0	115.4	95.4	97.4	102.7
11. 0-0-30	115.2	96.4	110.0	107.2
12. 0-0-0	112.0	95.2	97.4	101.5
C. Conventional Tillaae				
13. 15-30-30	129.2	106.0	95.8	110.3
14. 0-0-0	111.8	82.4	104.0	99.4
LSD.05	NS	12.0	18.5	NS
CV %	14.4	9.9	13.9	13.6

Table 8. Three year (1991-93) average soybean leaf percent nitrogen. potassium, and phosphorus at early bloom as influenced by tillage and starter fertilizer rate applied as a surface band application on a Leeper silty clay soil at the MAFES Northeast Mississippi Branch Station, Verona, MS.

Tillage Systems/ N-P_2O_5-K_2O lb/ac*	3 yr average % N	% P	% K
A. No-Tillage			
1. 15-30-30	4.6	0.46	1.7
2. 15-30-0	4.8	0.46	1.6
3. 0-30-0	4.9	0.48	1.5
4. 15-0-0	4.6	0.48	1.5
5. 0-0-30	4.9	0.49	1.6
6. 0-0-0	4.7	0.46	1.5
B. Reduced Tiilaae			
7. 15-30-30	4.9	0.46	1.6
8. 15-30-0	4.6	0.48	1.4
9. 0-30-0	4.7	0.46	1.5
10. 15-0-0	4.5	0.47	1.6
11. 0-0-30	5.0	0.47	1.6
12. 0-0-0	4.8	0.48	1.6
C. Conventional Tillage			
13. 15-30-30	4.9	0.47	1.6
14. 0-0-0	5.0	0.47	1.4
LSD 0.05	NS	NS	NS
CV %			

* All N-P-K fertilizer solutions applied as a 4-in wide surface band over the planted row.

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